Electric Vehicles at Scale (VAN049)

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Overview

Project Start: Jun 2020 || **End:** Sep 2021 || **Percent Complete:** 100%

Funding: $550k, (100% DOE)

Partners: Southern California Edison (SCE)

Challenge: Wide-scale adoption of EVs could be limited if we don't address the distribution system challenge. Current distribution system planning practices don't reflect locational aspects of growing EV loads.

Barriers Addressed:

- ❑ Diversity in distribution system circuits across the country (e.g., customer composition, topology) challenges tool development.
- ❑ Uncertainty surrounding EV adoption, charging infrastructure and human behaviors makes distribution investment planning difficult.
- ❑ Lack of efficient methodologies and data to estimate adoption at circuit & customer-level EV adoption.

Relevance

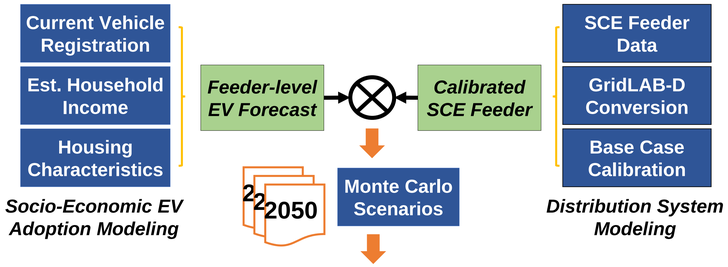
Key Questions
- How to determine the EV hosting capacity of utility circuits?
- How does mitigation through smart charge management (SCM) enhance EV hosting capacity?
- How can planning tools be updated for EV growth?

Outcomes
- Socio-economic data-based, circuit-level EV forecast and adoption methodology.
- Results and methodology of high interest to SCE. SCE will adopt methodology for more circuits.
- Insights into value of SCM

Impact on Barriers
- The socio-economic EV adoption forecast methodology provides customer & feeder-level forecasts.
- The methodology uses household income and home price data to minimize forecast uncertainty.

Impact on Sub-program Objectives
- This project enables distribution system planners to plan for infrastructure upgrades, to avoid infrastructure limitations hindering continual growth in EV adoption.

Approach



Impact Metrics	
Transformer thermal violation	100% rating exceedance for line, 180% for service transformers
Line thermal violation	
ANSI A: 5 min voltage violation	$0.95 > V > 1.05$ pu
ANSI B: Instant voltage violation	$0.90 > V > 1.10$ pu

Technical Accomplishments

A) An ***EV Adoption Model*** that uses household income estimates, housing characteristics, vehicle registrations, and vehicle price data to develop customer-level EV adoption probabilities.

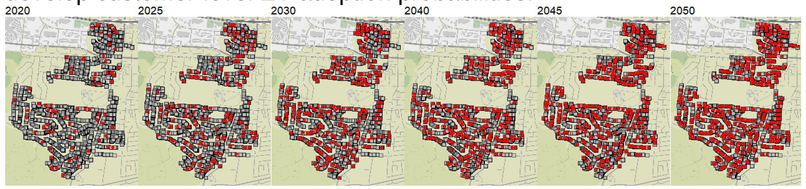
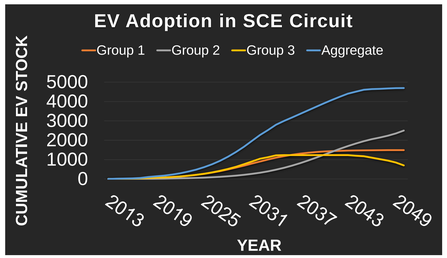


Figure: Representation of growth in EV Adoption with every study year

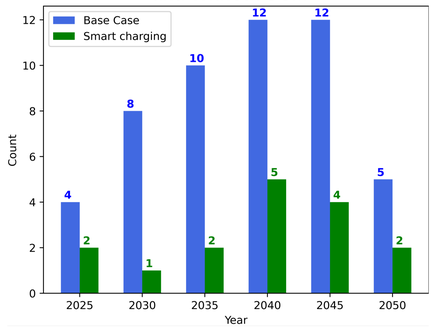


The model breaks down adoption into three groups for every study year:

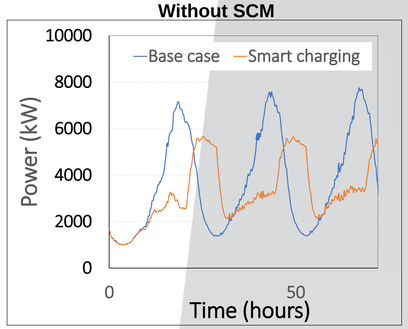
Group	EV Range
Group 1	25-300 mi
Group 2	60-275 mi
Group 3	PHEV 18-80 mi

B) The ***grid analysis*** identified the number of transformers that may be constrained with growth in EV adoption in subsequent years. The mitigation analysis highlighted the value of SCM to enhance the hosting capacity and delay need for infrastructure upgrades.

Required Transformer Upgrades With and Without SCM



Substation Load Profile With and Without SCM



Collaboration and Coordination

- Southern California Edison is our utility partner
- SCE is interested in applying EV adoption methodology to larger number of circuits
- Methodology directly applicable to other utility organizations

Proposed Future Research#

- Development of a tool for distribution utilities to perform circuit planning in the context of growing EV adoption
- Enhancement of EV penetration model for commercial fleets (LDV, MDV, HDV)

- Any proposed future work is subject to change based on funding levels

Summary

- ❑ Circuit-level EV adoption forecasting is essential to effectively determine impact of EV charging on feeder operation
- ❑ Current utility planning tools need to be updated with circuit-specific EV adoption models to accurately determine circuit upgrades necessary to accommodate EV growth
- ❑ The outcomes from this project directly address these needs:
  - A socio-economic EV adoption forecast methodology that outputs circuit-level adoption
  - A methodology for utilities to perform infrastructure upgrade planning in the context of EVs

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